

Great Lakes Wind on the Water Group PSCW Docket # 5-EI-144

20% Wind Energy by 2030 and the Role of Off-Shore Wind Power

Jeff Anthony
American Wind Energy Association
Wednesday, June 11th

20% Wind Energy
by 2030

Who is AWEA ?

- » American Wind Energy Association
 - www.awea.org
- » National Trade Association for Wind Industry
 - Legislative / Lobbying
 - Education & Outreach
 - Member Services
- » Currently >1300 business, utility, academic, and non-profit members

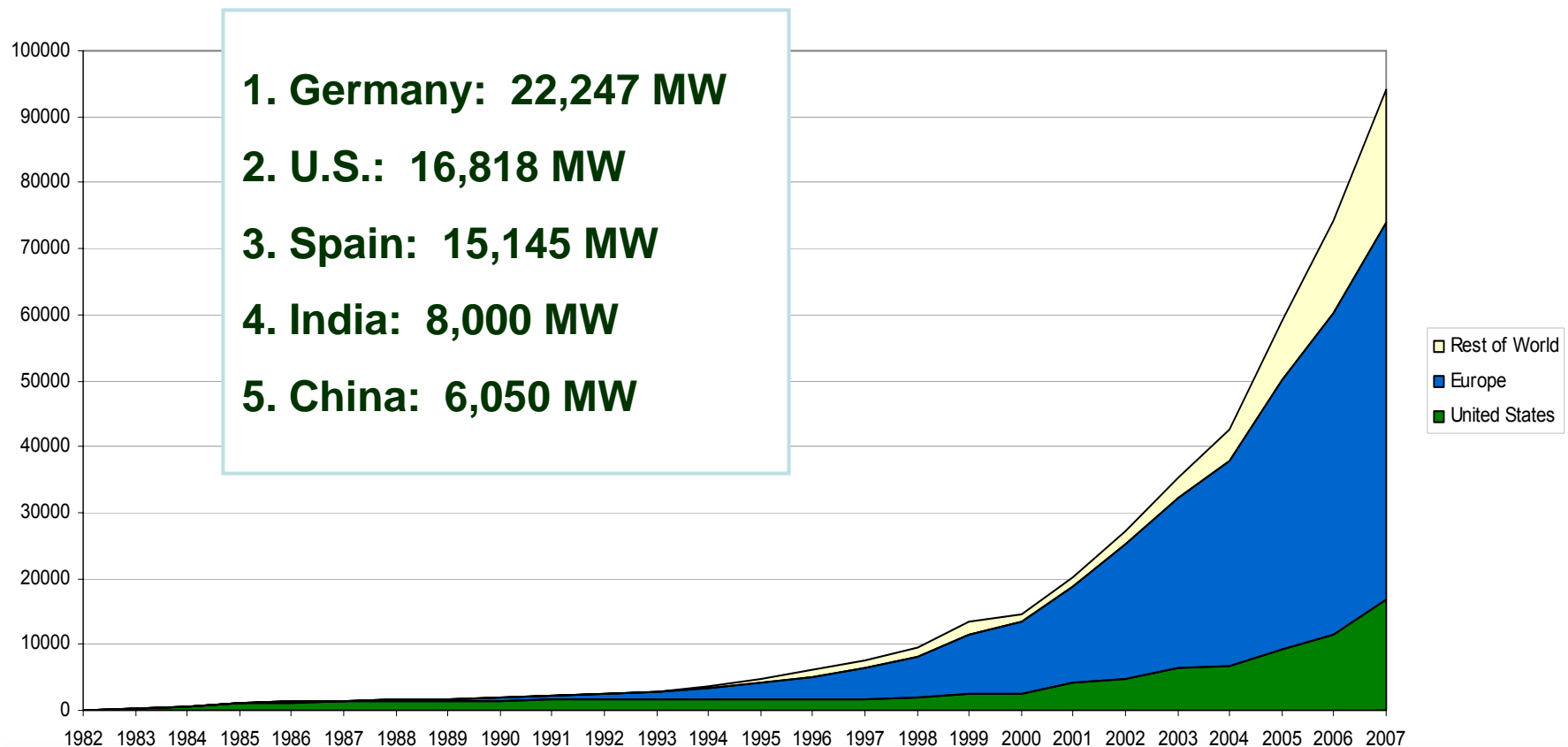
20% Wind Energy
by 2030

Outline of Presentation

- » Introduction
- » Wind Power Market Overview
- » Wind Integration / Energy Storage Issues
- » 20% Wind Energy by 2030
- » AWEA Off-Shore Wind Overview
- » Your Questions

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by 2030

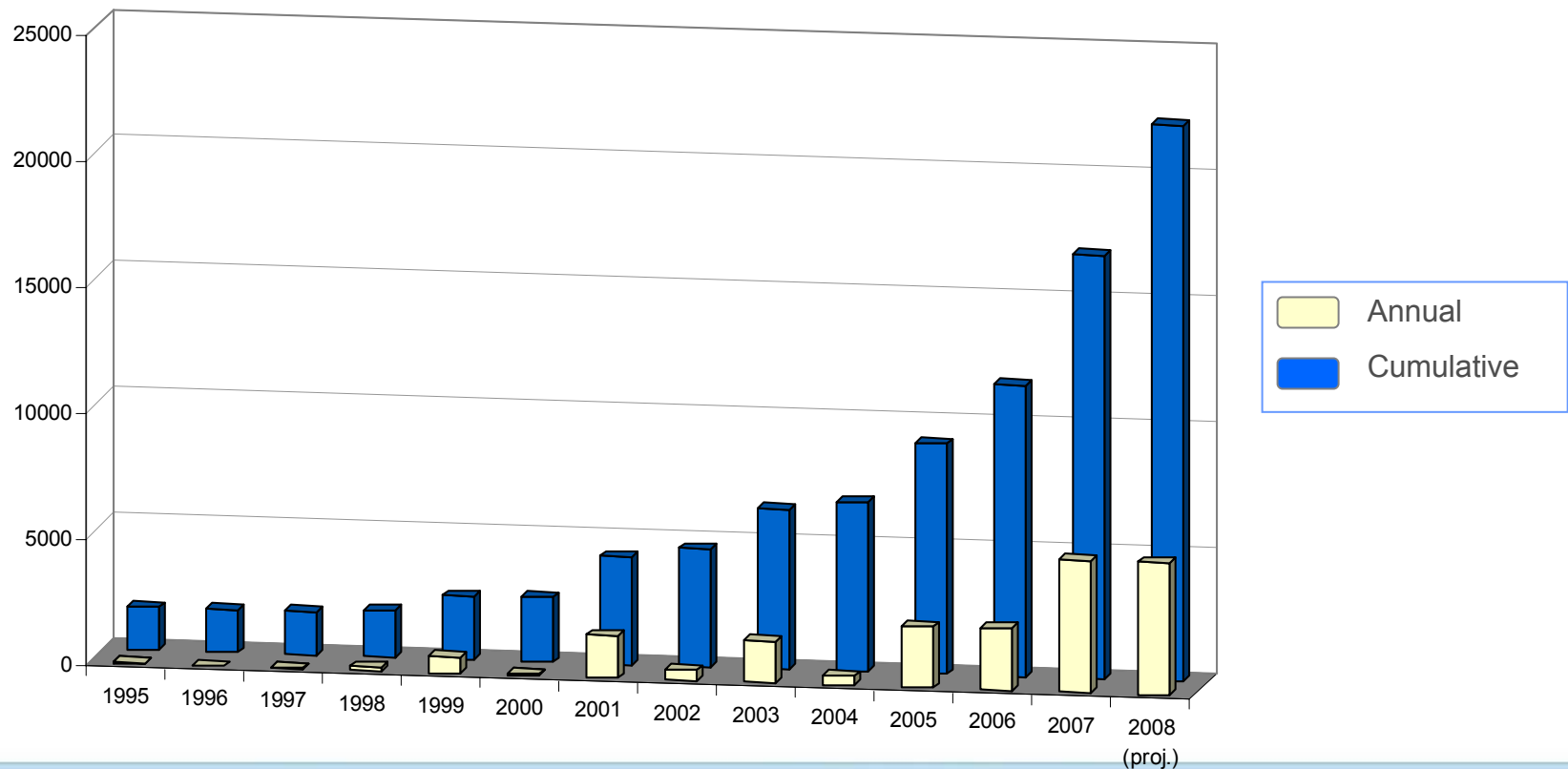
Wind Power Market Overview



Source: GWEC Global Market Report
As of December 31, 2007

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Wind Power Taking off in U.S.

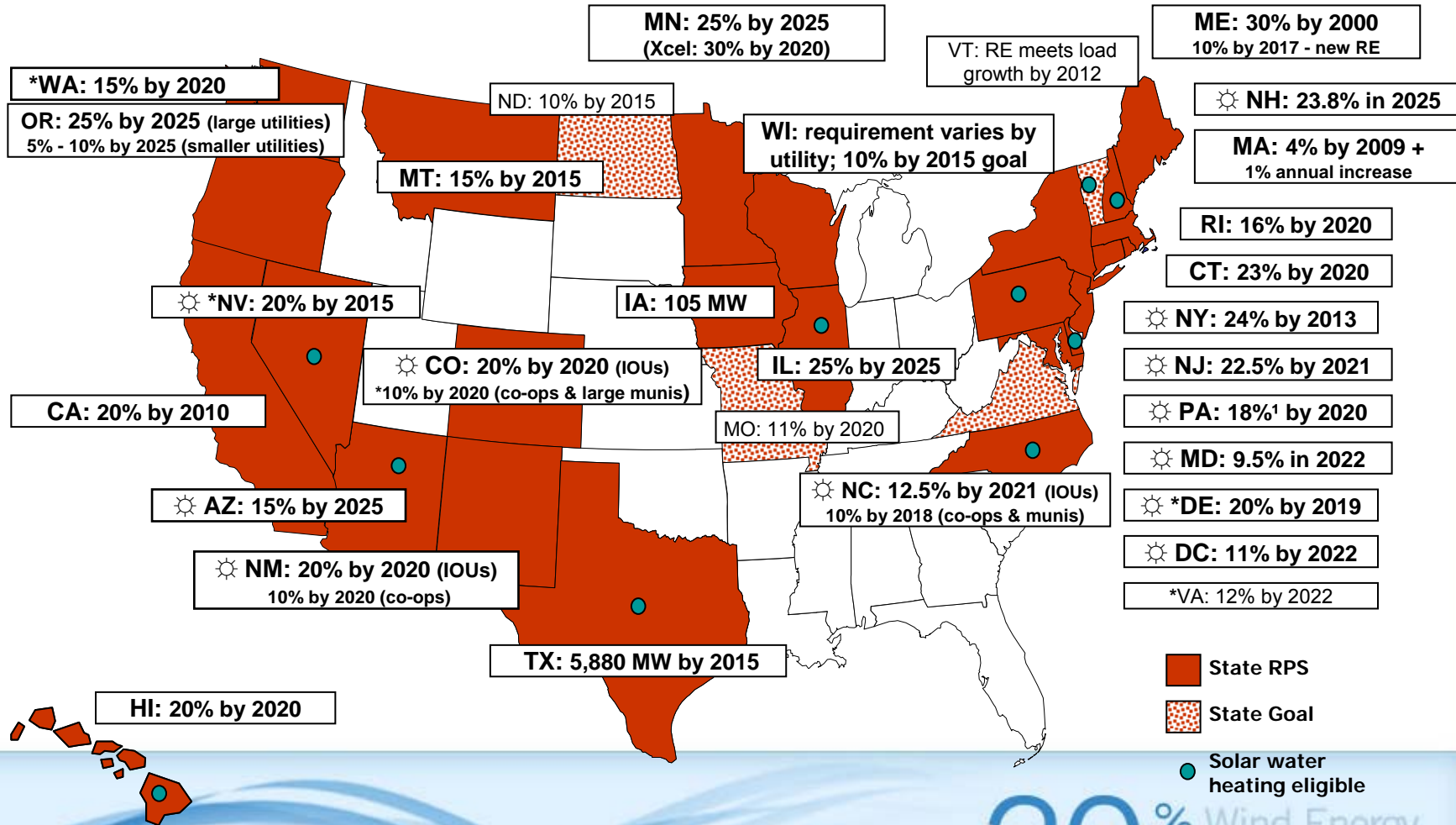


Source: AWEA Market Report

As of December 31, 2007

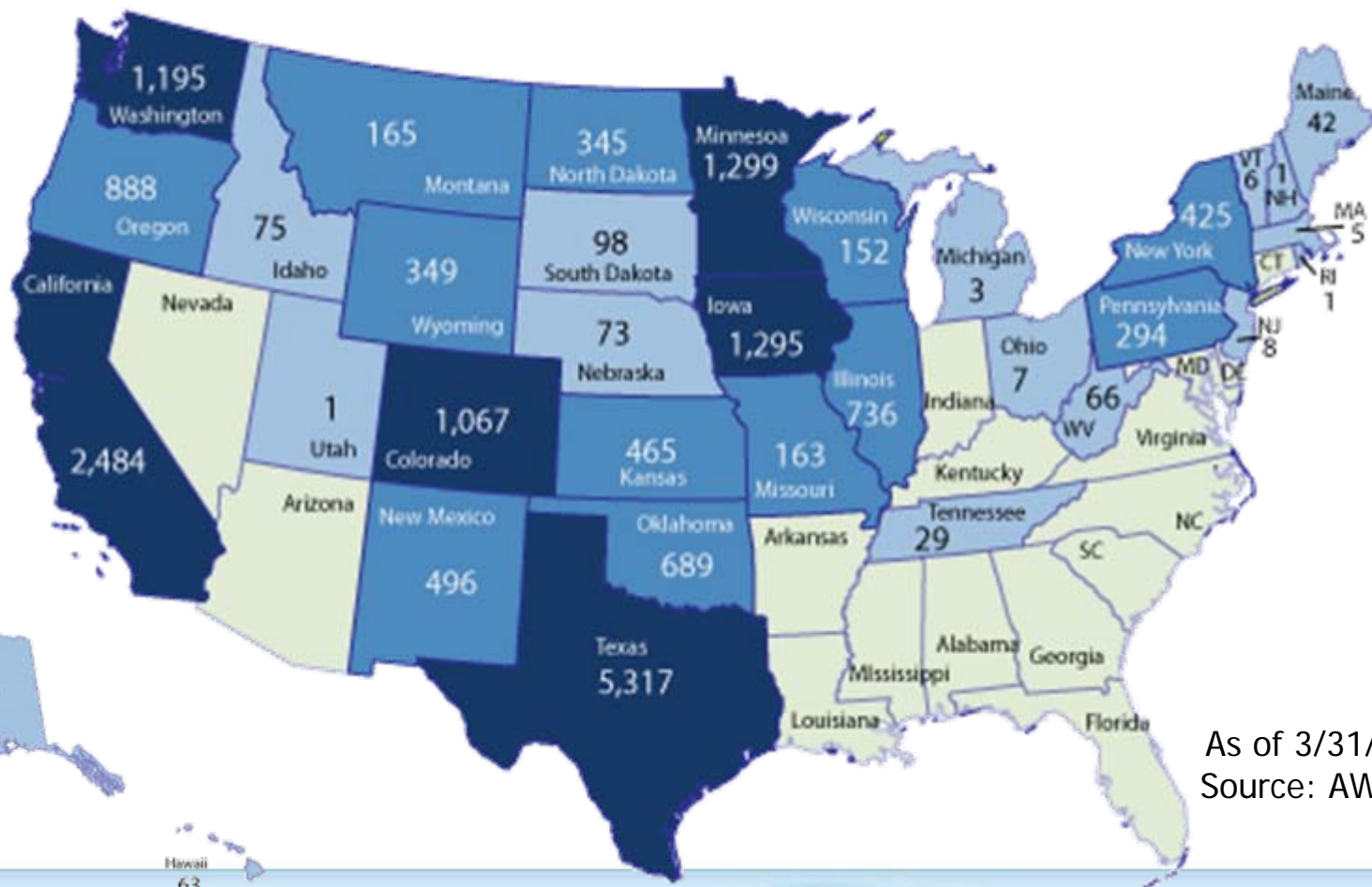
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State RPS Requirements



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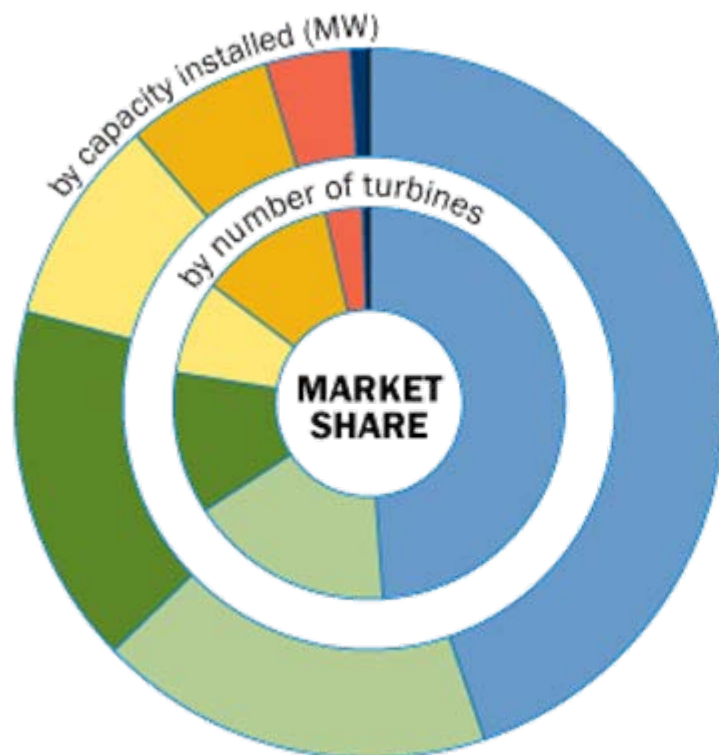
Current U.S. Wind Power Installations



As of 3/31/08
Source: AWEA

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Turbine Manufacturers, 2007 Projects



Installed in 2007

Company	MW	Turbines
GE Energy	2,342	1,561
Vestas	953	537
Siemens	863	375
Gamesa	484	242
Mitsubishi Power Systems	356	356
Suzlon	197	97
Clipper	48	19
Nordex	2.5	1

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Wind Integration / Energy Storage

- » Wind Power output is “variable”, not “intermittent”
- » Wind Power Availability > 95%
- » Integrating Variable Resources
 - Wind Integration Studies in NY, MN, CA
 - Results: minimal impacts, costs
 - Best when robust markets exist
 - Wind Forecasting plays an increasingly important role
 - Major studies underway in West and MISO/SPP/TVA/PJM



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Wind Power & Energy Storage

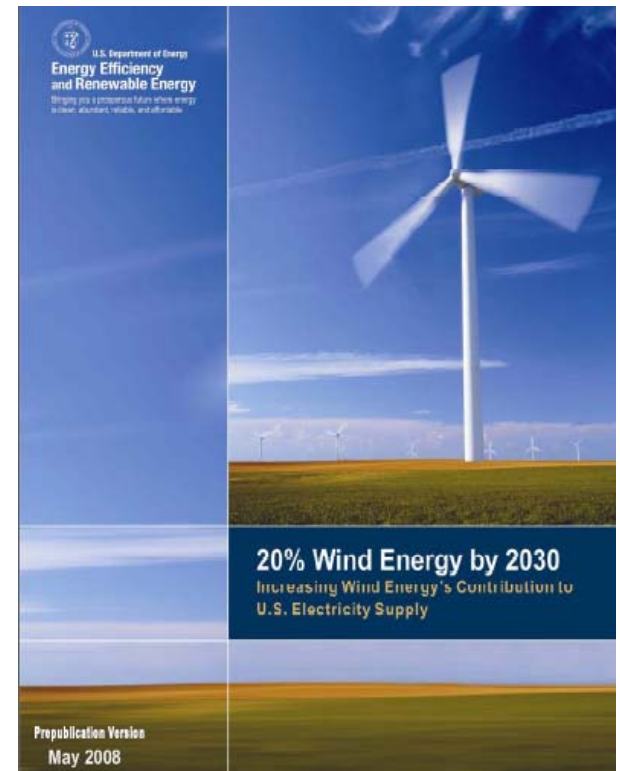
- » Due to inherent system variability, storage can contribute to system flexibility regardless of the role of wind power or renewable energy resources
- » No Study or Report shows that new storage is needed to achieve 20% energy production from wind energy
- » Experience from Europe shows that an electric system can be operated with over 20% wind energy on the system without added storage requirements

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by 2030

20% Wind Energy by 2030

In 2006, President Bush emphasized the nation's need for greater energy efficiency and a more diversified energy portfolio.

This led to a collaborative effort of government and industry to explore a modeled energy scenario in which wind provides 20% of U.S. electricity by 2030.



20% Wind Energy
by 2030

Report Overview

The report considers some associated **challenges**, estimates the **impacts** and considers specific **needs and outcomes** in terms of:

- » Wind Turbine Technology;
- » Manufacturing, Materials, and Resources;
- » Transmission and Integration into the U.S. System;
- » Siting and Environmental Effects;
- » Wind Power Markets.

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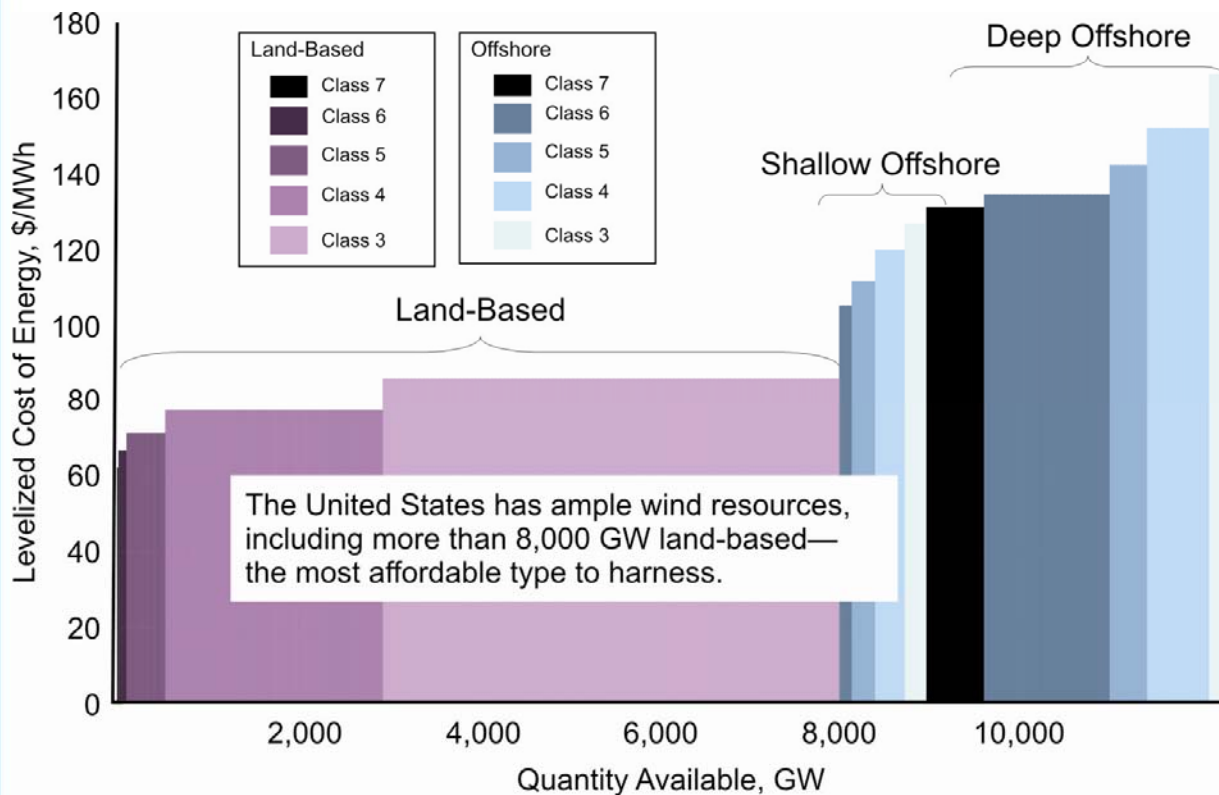
Key Issues Examined

- » Does the nation have sufficient wind energy resources?
- » What are the wind technology requirements?
- » Does sufficient manufacturing capability exist?
- » What are some of the key impacts?
- » Can the electric network accommodate 20% wind?
- » What are the environmental impacts?
- » Is the scenario feasible?

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Wind Resource Supply Curves

Wind Resource Potential in the U.S.



The technical wind resource potential far exceeds the total electricity demand of the entire U.S.

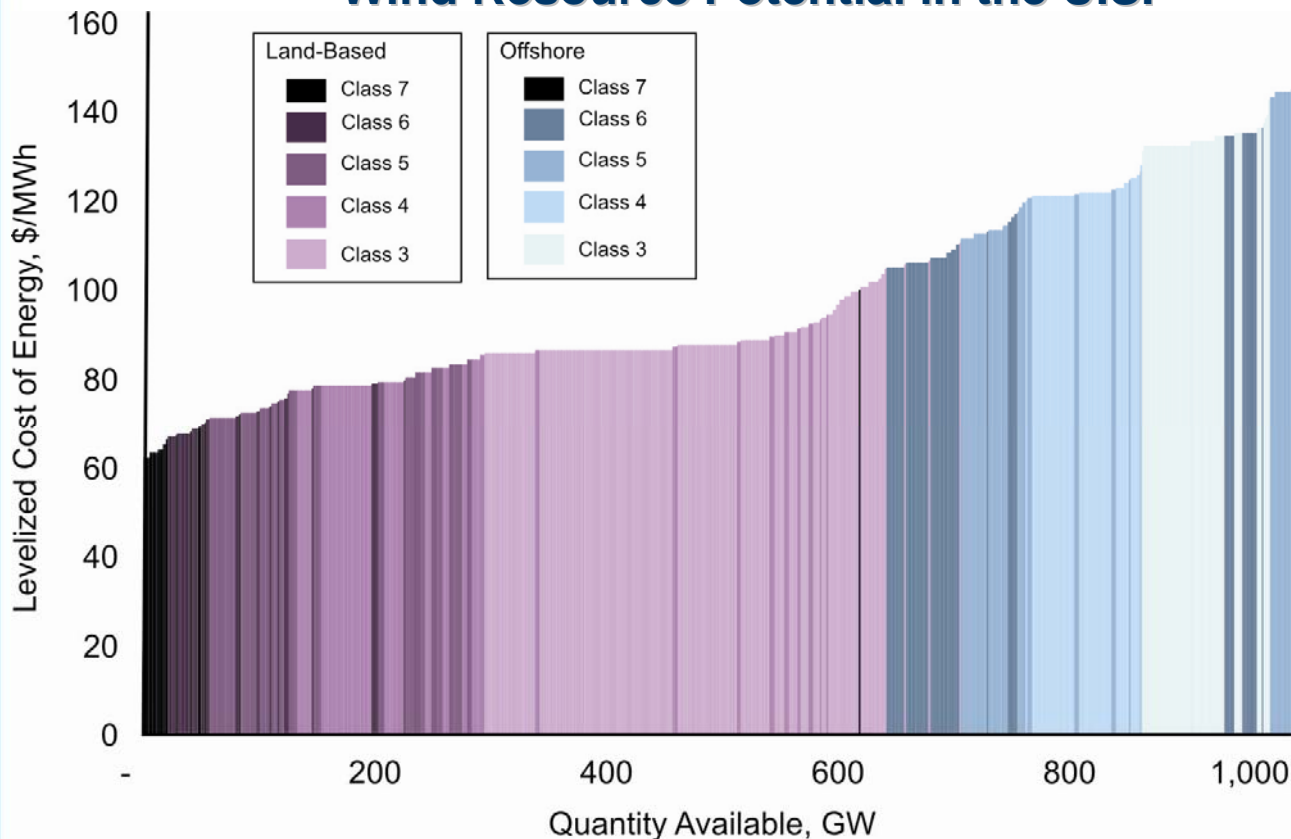
Onshore technical wind resource exceeds 8,000 GW (8,000,000 MW), accounting for standard land exclusions.

Costs not including PTC, Transmission and Integration costs

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Wind Resource Supply Curves

Wind Resource Potential in the U.S.



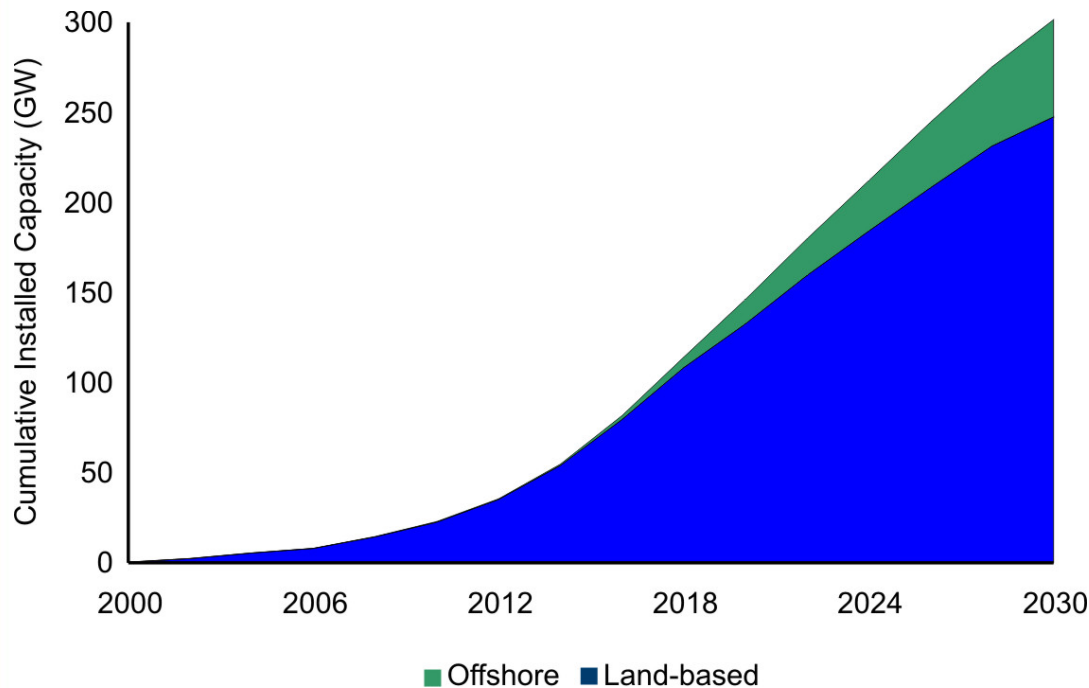
Once the cost of transmission and integration is included, over 600 GW of wind is still available for less than 10 cents/kWh.

Costs including Transmission and Integration costs, but no Federal PTC

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Onshore and Offshore Wind Capacity

Cumulative Wind Installations by 2030



The 20% wind Scenario would include both onshore and offshore wind energy.

Of the total 305 GW of installed capacity, approximately 240 GW would be installed onshore and approximately 65 GW would be installed offshore.

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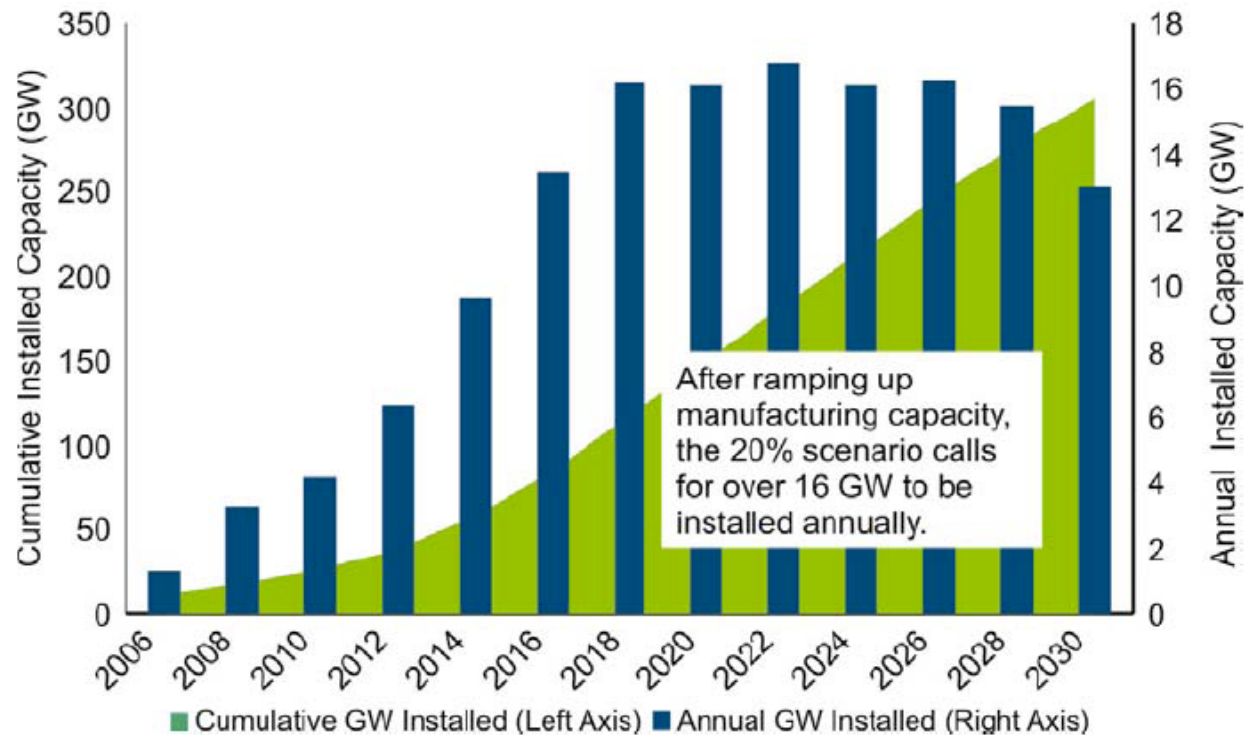
Growth Path to 20% Wind by 2030

Only a fraction of total wind potential would be needed to reach 20%.

Total capacity would grow to nearly 305,000 MW, or an additional 293,000 MW over the 11,600 MW installed at the end of 2006.

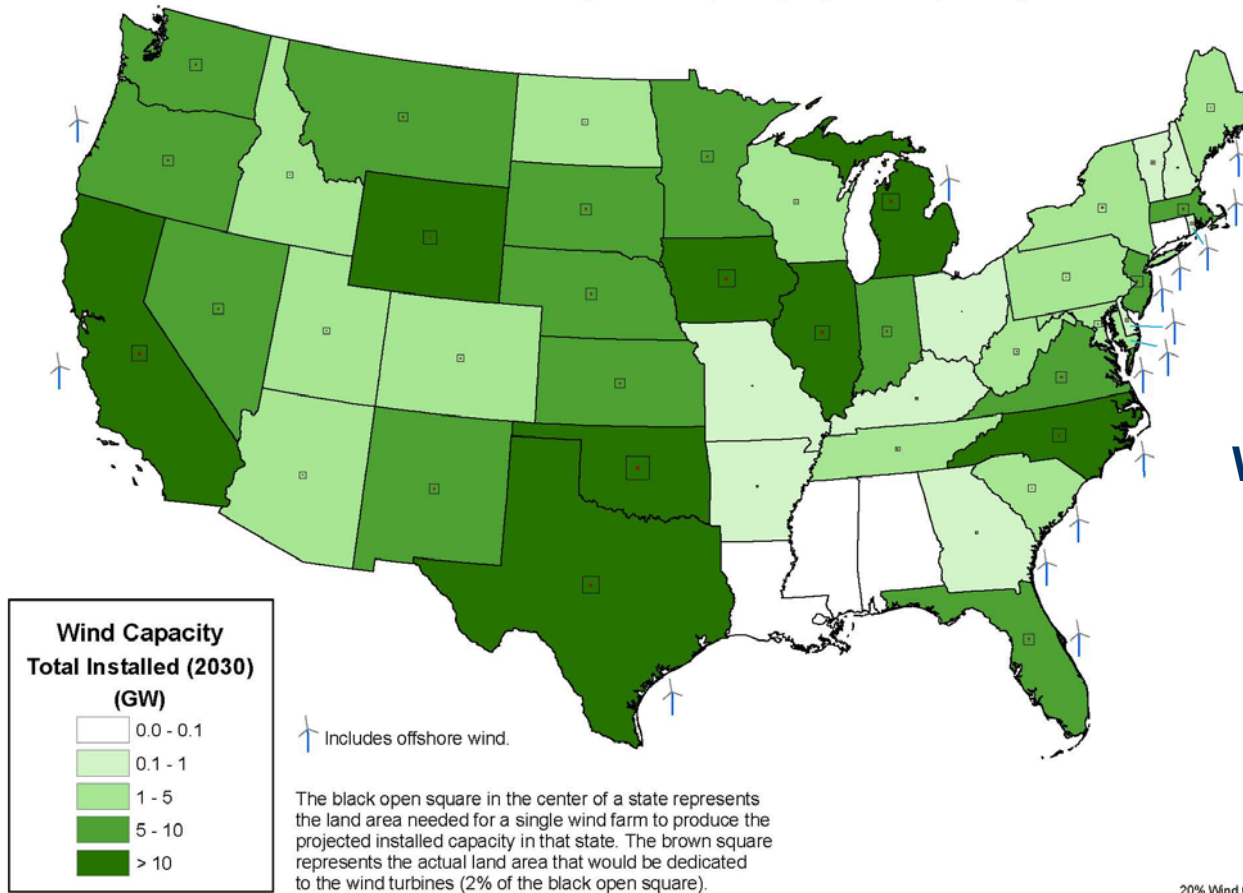
Annual installations increase to over 16,000 MW per year by 2018.

Annual and Cumulative Wind Installations by 2030



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Wind Capacity by State



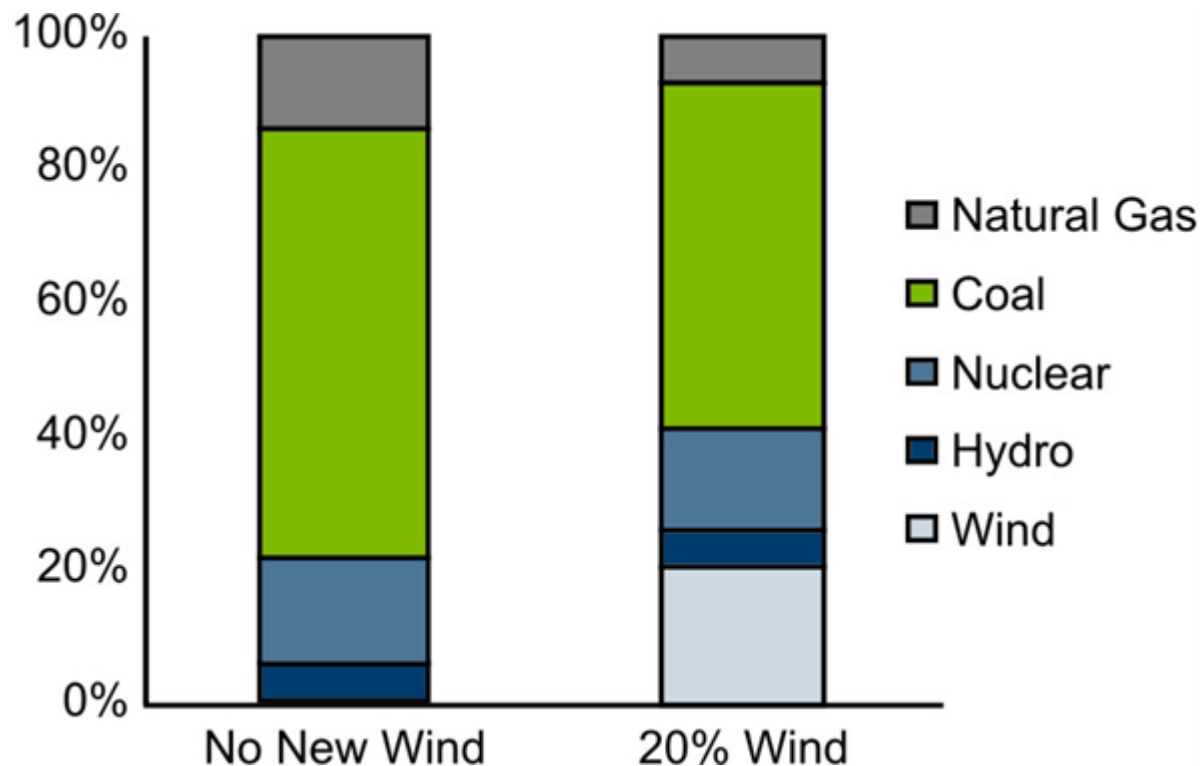
**Installed Wind
Nameplate Capacity
by State (2030)**

**Wind capacity would be
installed across 46
states in the 20% wind
scenario.**

20% Wind 06-19:

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Electricity Generation Mix



**The 20% Wind Scenario
would decrease
generation from natural
gas by 50% and
generation from
coal by 18%.**

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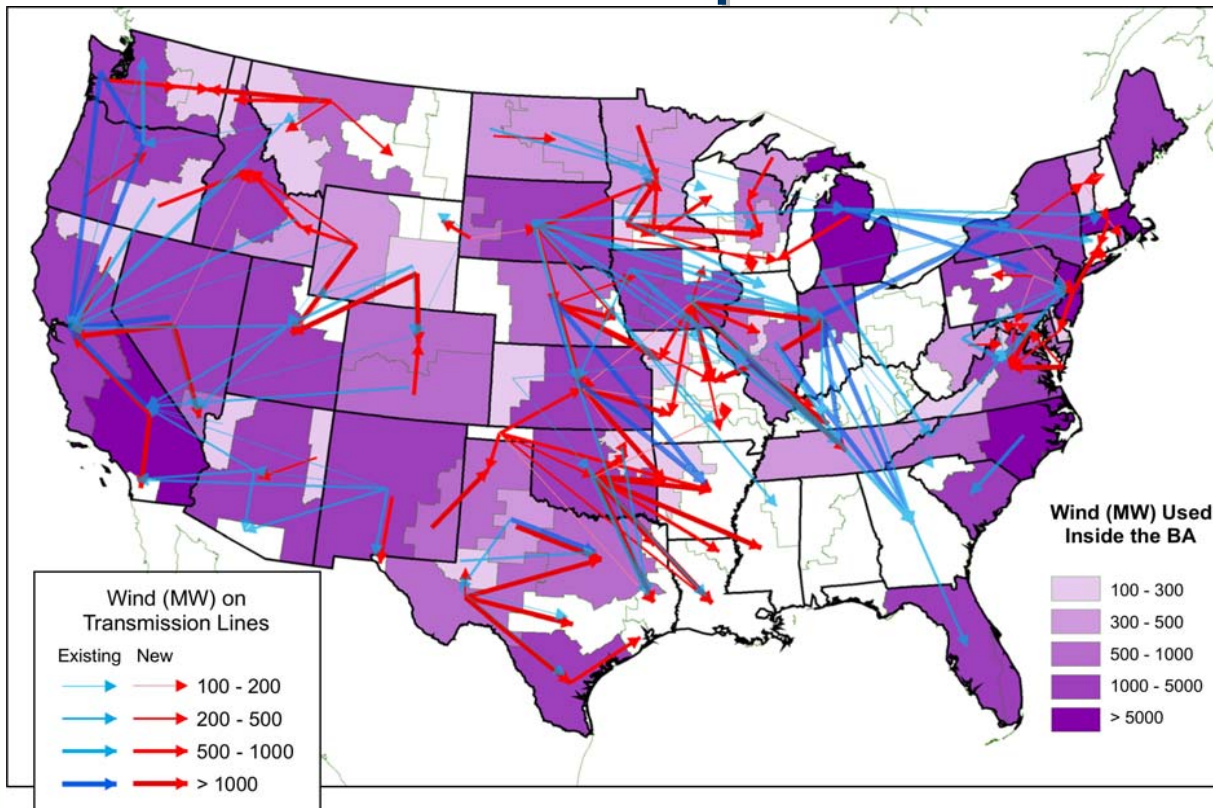
Natural Gas Benefits By 2030

- » Reduces total U.S. natural gas use by 11%
- » Reduces natural gas prices by 12% or \$0.90 per MMBtu
- » Saves \$128 billion in net present value over the 23-year period

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Transmission Expansion

Expansion of U.S. Transmission by 2030 under the 20% Wind scenario.

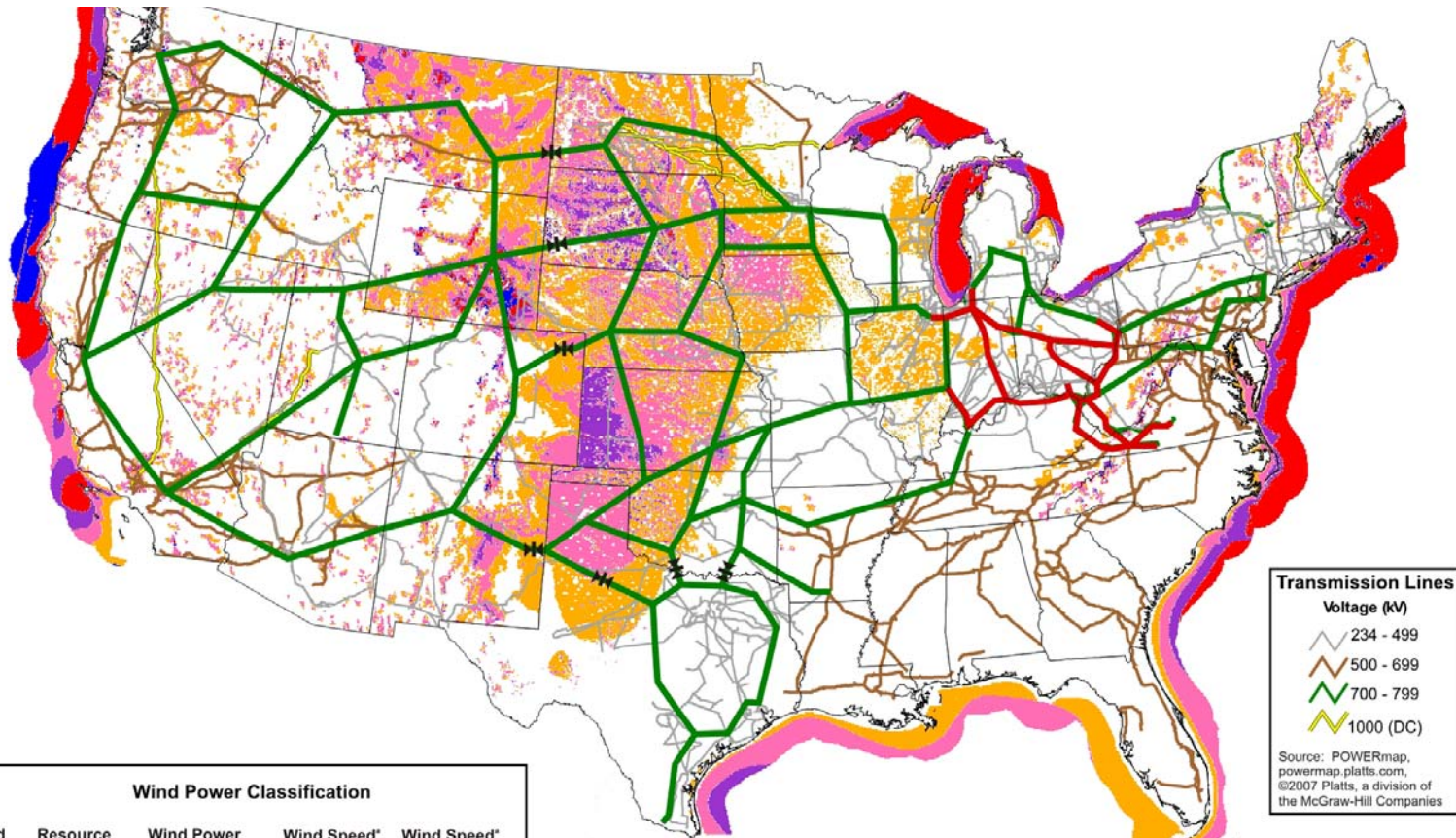


Total Between Balancing Areas Transfer ≥ 100 MW (all power classes, land-based and offshore) in 2030. Wind power can be used locally within a Balancing Area (BA), represented by purple shading, or transferred out of the area on new or existing transmission lines, represented by red or blue arrows. Arrows originate and terminate at the centroid of the BA for visualization purposes; they do not represent physical locations of transmission lines.

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Conceptual Transmission Plan

AEP's Conceptual Plan to Accommodate 400 GW of Wind Energy



Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m ²	Wind Speed* at 50 m m/s	Wind Speed* at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

* Wind speeds are based on a Weibull k value of 2.0

This map shows the wind resource data used by the WinDS model for the 20% Wind Scenario. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.

Conceptual 765 kV Network

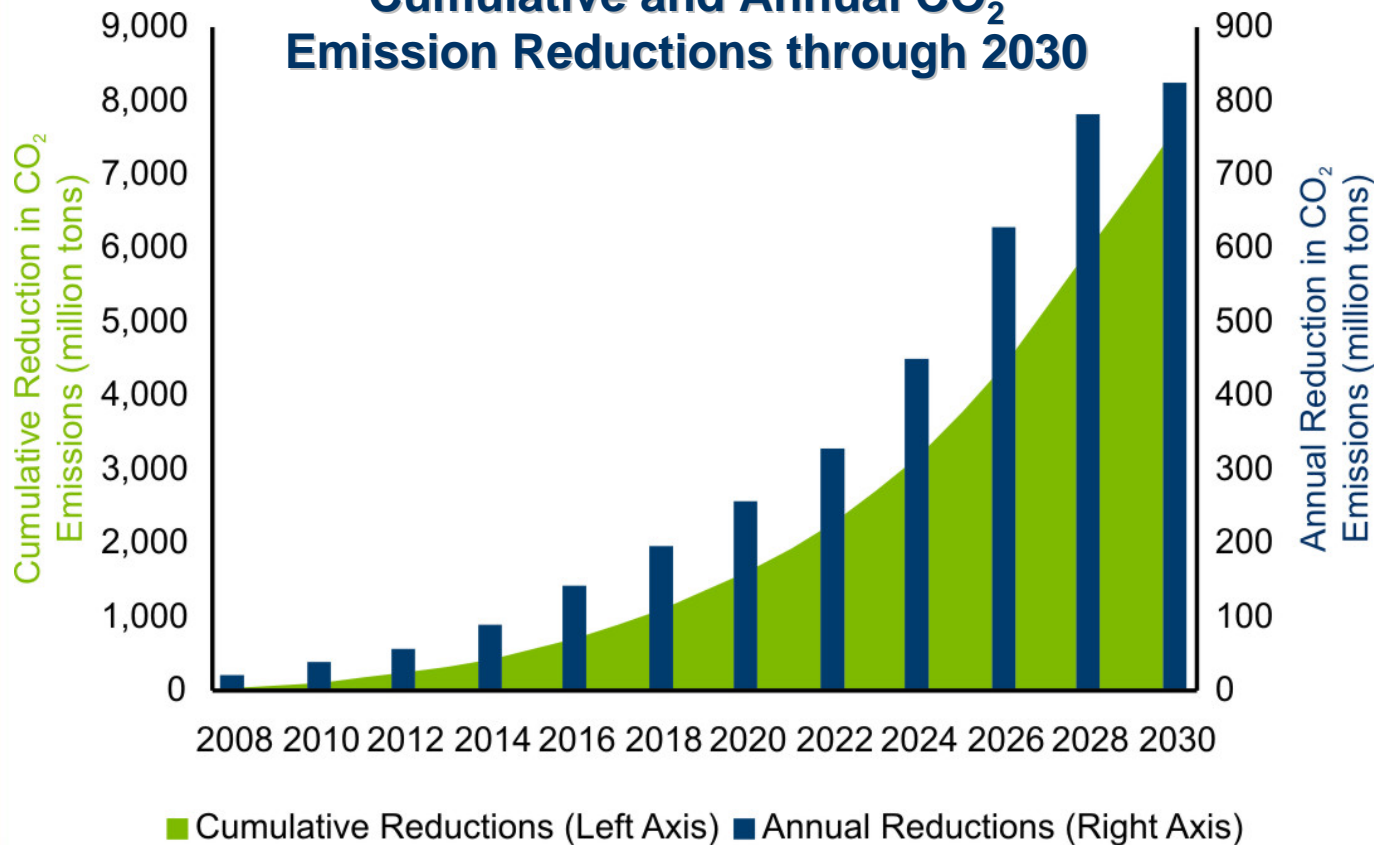
- Existing 765 kV
- New 765 kV
- AC-DC-AC Link

Source: American Electric Power (AEP)

energy
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CO₂ Emission Reductions

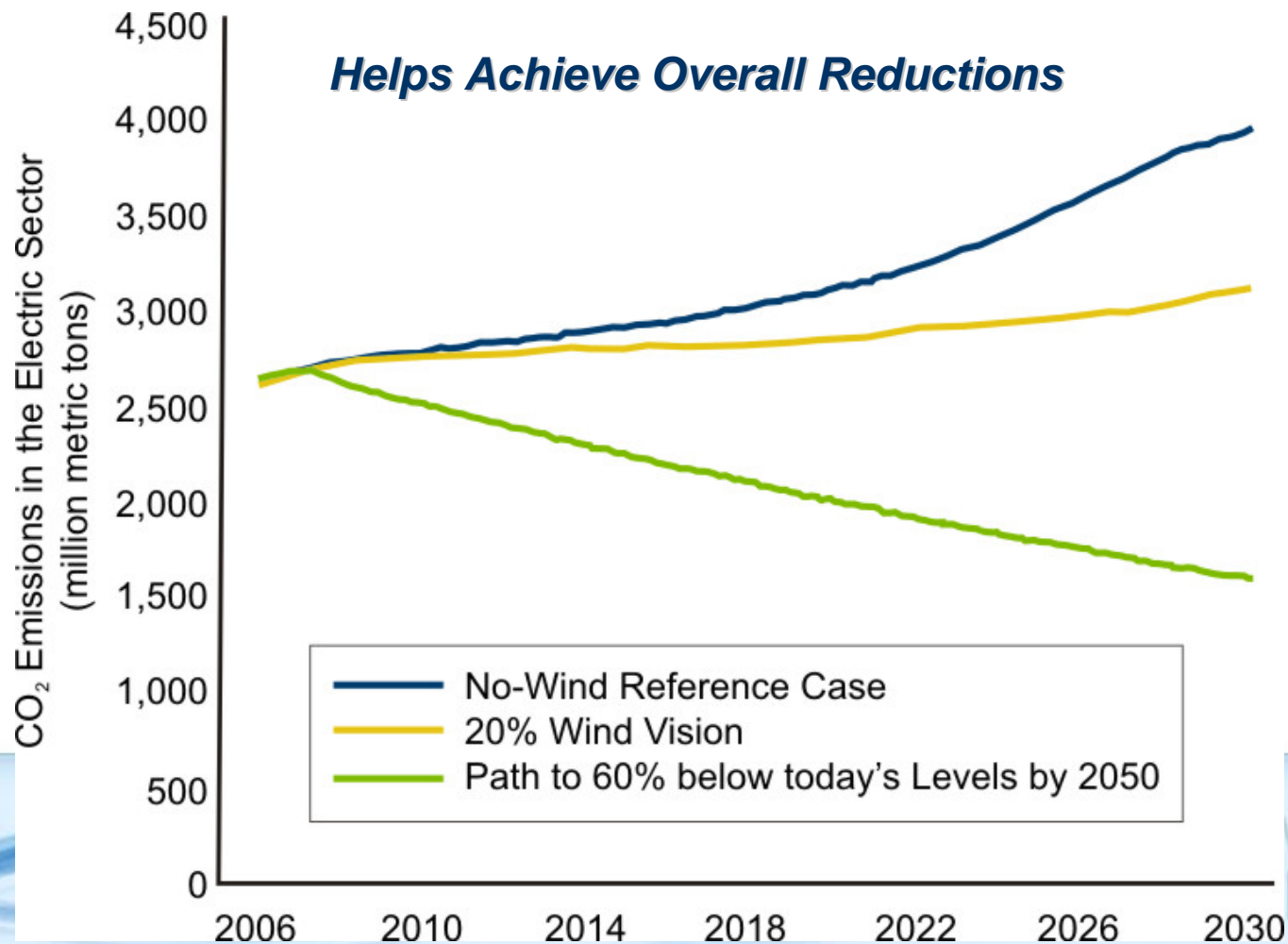
**Cumulative and Annual CO₂
Emission Reductions through 2030**



Annual reductions would reach 825 million tons of CO₂ by 2030, an equivalent a **reduction of 25%** of expected electric sector emissions by 2030.

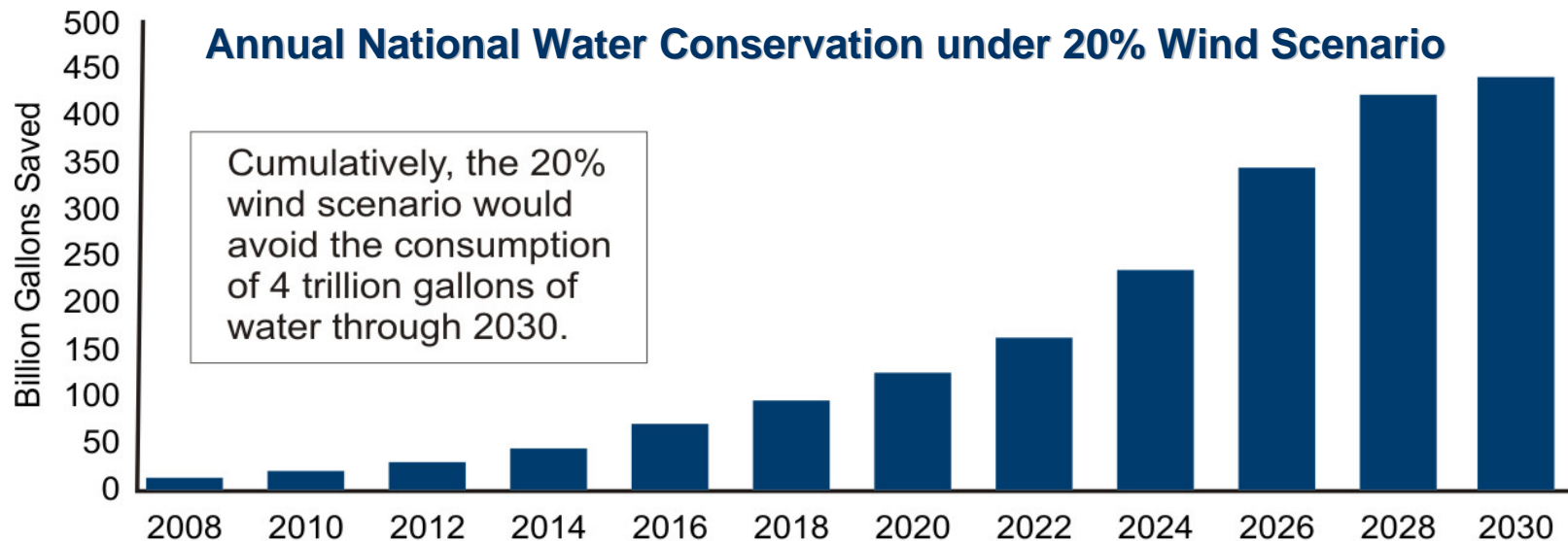
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20% Wind Flattens Electric Industry CO₂ Emissions



Water Conservation

- » Cumulatively between 2007 and 2030, 20% wind reduces water consumption in the electric sector by 8%, or 4 trillion gallons.
- » In 2030, reduces water consumption by 450 billion gallons or 17% of total electric sector water consumption, a third of water conservation occurs in the arid west.



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20% Wind: Supply Challenges

Major Current Constraints:

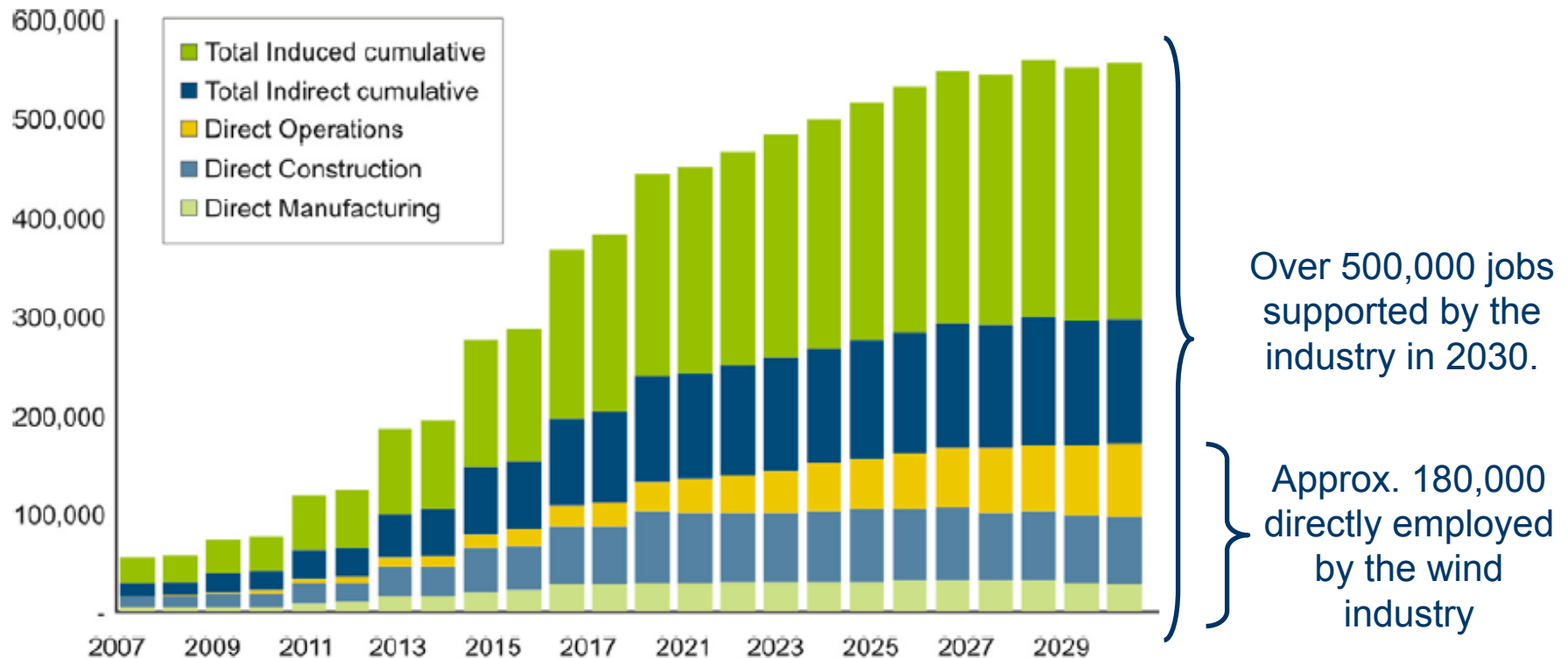
- » Large Bearings
- » Industrial Gear boxes
- » Generators/ Generator Components

Anticipated Constraints:

- » Crane Availability
- » Domestic Transport Capacity & Permitting
- » Operations & Maintenance Human Resources

Employment Impacts

Industry Employment from direct, indirect, and induced categories



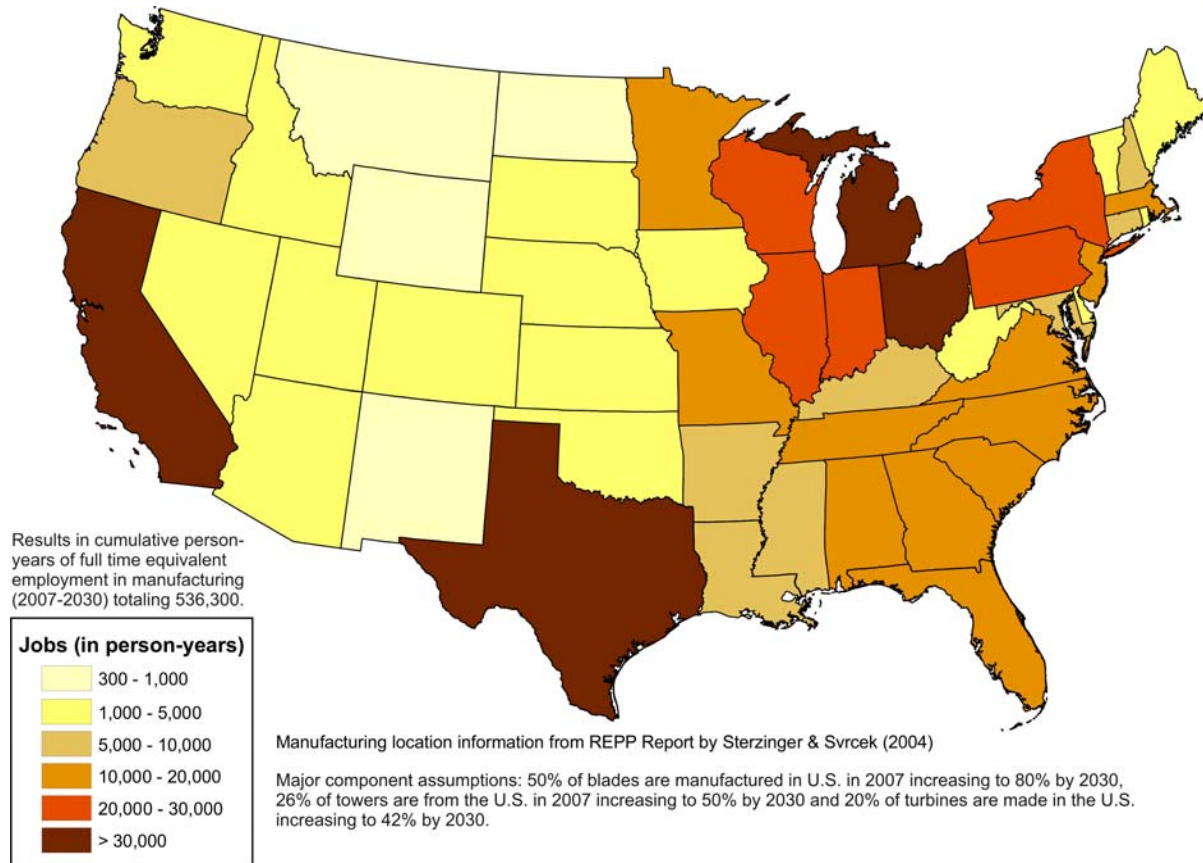
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Employment Impacts: Manufacturing

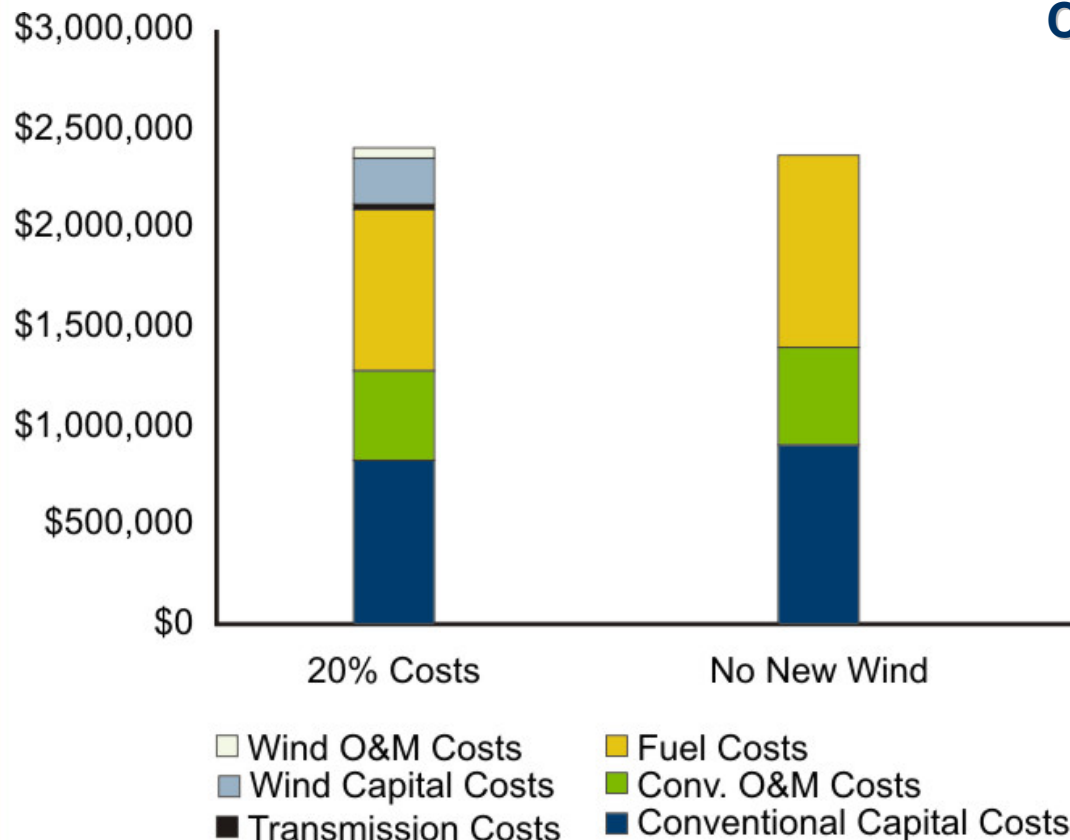
Possible Distribution of Wind Equipment Manufacturing Jobs

Of the 180,000 jobs directly employed by the wind industry, there are over **40,000** direct manufacturing jobs in 2030.

Cumulatively, there is employment of 536,300 FTE in direct manufacturing between 2007 and 2030.



Estimated Electric System Costs



Cumulative Discounted Electric System Cost through 2030 (Millions of 2006 Dollars)

Approximately a 2%
increase in cost, or
\$43 billion in net present
value.

Equivalent of 50 cents
per month per
household, not
accounting for positive,
offsetting impacts.

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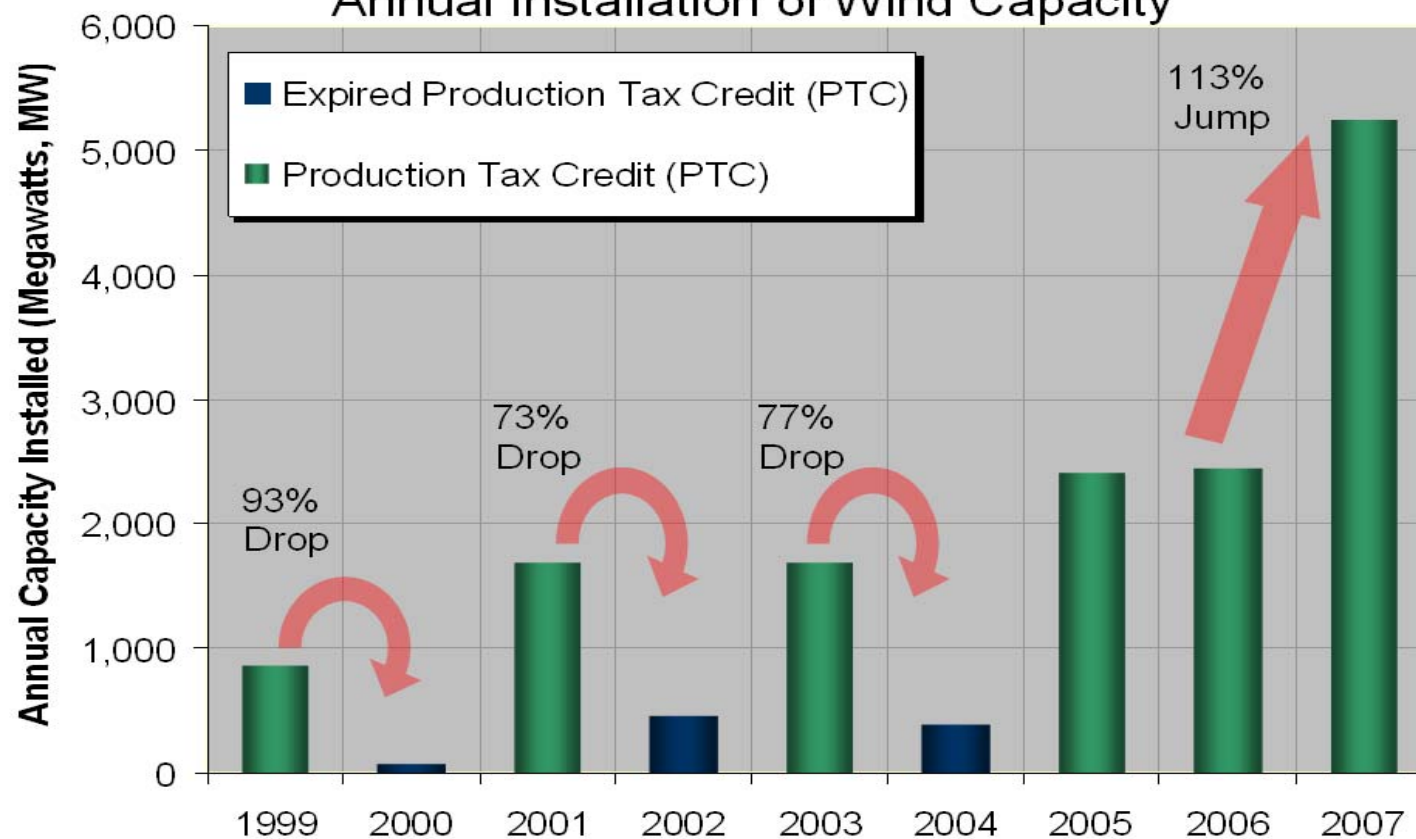
Results: Costs and Benefits

- **Incremental direct cost to society** **\$43 billion**
- **Reductions in emissions of greenhouse gases and other atmospheric pollutants** 825 M tons (2030)
\$98 billion
- **Reductions in water consumption** 8% total electric
17% in 2030
- **Jobs created and other economic benefits** 140,000 direct
\$450 billion total
- **Reductions in natural gas use and price pressure** 11%
\$150 billion

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20% Vision: Policy Challenges

Historic Impact of PTC Expiration on Annual Installation of Wind Capacity



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Off-Shore Wind Power Overview

- » Drivers for off-shore wind power
- » European experience
- » Proposed projects in the U.S.
- » 20% Wind Energy by 2030 – off-shore wind contribution
- » Barriers to Off-Shore Wind Power in the U.S.

20% Wind Energy
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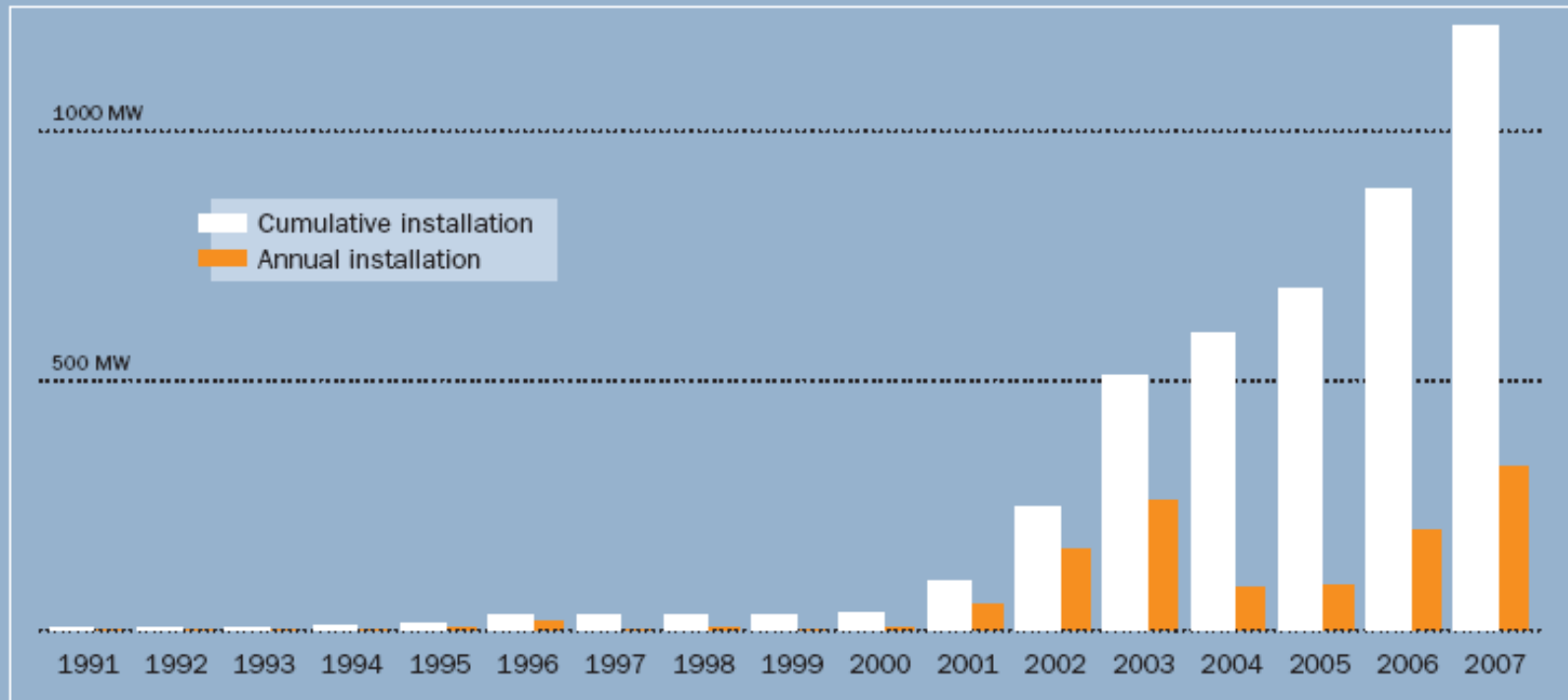
Drivers for Offshore Wind Energy

- » Access to wind resource
- » Access to customer demand
- » Only option for large-scale renewable energy in some places
- » Economic opportunities
- » Limited impacts
- » Demonstrated technology

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Offshore Wind Projects Installed

FIGURE 1: Offshore wind market development in Europe (1991-2007)



Source: European Wind Energy Association, *Delivering Offshore Wind Power in Europe*, November 2007

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Proposed Offshore Projects in the U.S.

Cape Wind	Nantucket Sound	130 turbines	Moving through MMS process
FPL Energy	Long Island Sound	40 turbines	Project on hold
W.E.S.T.	Galveston, TX	50-60 turbines	Signed lease with General Land Office
Bluewater Wind	Delaware	200 turbines	Awaiting state approval of contract
Hull Municipal	Boston Harbor	4 turbines	Site data collection underway
Patriot Renewables	Buzzards Bay, MA	90-120 turbines	Site studies underway
Southern Company	Georgia coast	3-5 turbines	Feasibility being studied
Great Lakes Wind Energy Center	Lake Erie	Up to 20 MW	Feasibility being studied

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20% Scenario – Offshore Installations

- » 54 GW of shallow offshore wind envisioned in the DOE 20% scenario
- » Installations primarily in the Northeast, Mid-Atlantic and Great Lakes

Barriers for Offshore Wind in the U.S.

- » Offshore wind turbine technology continues to develop
- » Evolving foundation designs
- » Cost reductions
- » Permitting regime
- » Long-term policy support

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Conclusions and Q&A

Your questions ?

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